

Having described the invention, we claim the following:

1. An occupant restraint system for helping to protect an occupant of a seat of a vehicle, the occupant restraint system comprising:

first and second lap belts for collectively extending across a lap of the occupant;

first and second shoulder belts for extending over the shoulders of the occupant;

a buckle assembly for interconnecting the lap belts and the shoulder belts, and

first and second buckle-lowering belts attached to the buckle assembly for creating a downwardly acting biasing force on the buckle assembly so as to move the buckle assembly downwardly relative to the seat and towards the lap of the occupant.

2. The occupant restraint system of claim 1 wherein the first and second buckle-lowering belts also collectively extend across the lap of the occupant.

3. The occupant restraint system of claim 2 further including at least one buckle-lowering

retractor, the first buckle-lowering belt having a first end that is attached to the buckle assembly and a second end that is attached to the at least one buckle-lowering retractor, the second buckle-lowering belt having a first end that is attached to the buckle assembly and a second end that is attached to the at least one buckle-lowering retractor.

4. The occupant restrains system of claim 3 further including at least one lap belt retractor for the first and second lap belts, the at least one buckle-lowering retractor located forward relative to the vehicle of the at least one lap belt retractor.

5. The occupant restraint system of claim 3 wherein an initial length of the first buckle-lowering belt extends between the at least one buckle-lowering retractor and the buckle assembly and an initial length of the second buckle-lowering belt extends between the at least one buckle-lowering retractor and the buckle assembly, the initial length of the first buckle-lowering belt and the initial length of the second buckle-lowering belt being substantially equal.

6. The occupant restraint system of claim 5 wherein a predetermined amount of the first buckle-lowering belt may be withdrawn from the at least one buckle-lowering retractor and a predetermined amount of the second buckle-lowering belt may be withdrawn from the at least one buckle-lowering retractor.

7. The occupant restraint system of claim 6 wherein the at least one retractor includes a first buckle-lowering retractor located on a first side of the seat and a second buckle-lowering retractor located on a second side of the seat, opposite the first side, the second end of the first buckle-lowering belt being attached to the first buckle-lowering retractor and the second end of the second buckle-lowering belt being attached to the second buckle-lowering retractor.

8. The occupant restraint system of claim 7 wherein the first buckle-lowering retractor includes a first spool and a first rewind spring, a portion of the first buckle-lowering belt being wound around the first spool, the first rewind spring biasing the first spool into a first position relative to the first buckle-lowering retractor, the initial length of the first

buckle-lowering belt extending between the first buckle-lowering retractor and the buckle assembly when the first spool is in the first position, the second buckle-lowering retractor includes a second spool and a second rewind spring, a portion of the second buckle-lowering belt being wound around the second spool, the second rewind spring biasing the second spool into a first position relative to the second buckle-lowering retractor, the initial length of the second buckle-lowering belt extending between the second buckle-lowering retractor and the buckle assembly when the second spool is in the first position.

9. The occupant restraint system of claim 8 wherein the first and second rewind springs tend to center the buckle assembly relative to the lap of the occupant when more than the initial lengths of the first and second buckle-lowering belts are withdrawn from the first and second buckle-lowering retractors, respectively.

10. The occupant restraint system of claim 3 wherein the at least one buckle-lowering retractor further includes at least one electric motor operable

for retracting the first and second buckle-lowering belts.

11. The occupant restraint system of claim 10 further including at least one controller for controlling actuation of the at least one electric motor of the at least one buckle-lowering retractor, the controller being responsive to a latch signal from a buckle switch and at least one of a tension signal from a first tension sensor and a position signal from a first position sensor.

12. The occupant restraint system of claim 3 wherein the at least one buckle-lowering retractor includes a spring having opposite first and second ends and a middle portion, the middle portion of the spring being fixed relative to the seat, the second end of the first buckle-lowering belt being attached to the first end of the spring and the second end of the second buckle-lowering belt being attached to the second end of the spring.

13. The occupant restraint system of claim 3 further including a first guide for guiding the first

buckle-lowering belt between the at least one buckle-lowering retractor and the buckle assembly and a second guide for guiding the second buckle-lowering belt between the at least one buckle-lowering retractor and the buckle assembly.

14. The occupant restraint system of claim 5 wherein the at least one buckle-lowering retractor includes a spool having first and second belt-receiving portions and a rewind spring, a portion of the first buckle-lowering belt being wound around the first belt-receiving portion of the spool and a portion of the second buckle-lowering belt being wound around the second belt-receiving portion of the spool, the rewind spring biasing the spool into a first position relative to the at least one buckle-lowering retractor, the initial lengths of the first and second buckle-lowering belts extending between the at least one buckle-lowering retractor and the buckle assembly when the spool is in the first position.

15. The occupant restraint system of claim 14 wherein the at least one buckle-lowering retractor further includes an electric motor operatively

connected to the spool and actuatable for rotating the spool in a direction for retracting the first and second buckle-lowering belts.

16. The occupant restraint system of claim 15 further including a controller for controlling actuation of the electric motor, the controller being responsive to a latch signal from a buckle switch and at least one of a tension signal from a tension sensor and a position signal from a position sensor.

17. The occupant restraint system of claim 6 wherein the at least one buckle-lowering retractor includes a mechanism for resisting withdrawal of the first buckle-lowering belt beyond the predetermined amount, the mechanism being actuatable for enabling withdrawal of the first buckle-lowering belt beyond the predetermined amount.

18. The occupant restraint system of claim 17 wherein the mechanism includes at least one gear wheel that is rotated in response to rotation of a spool of the at least one buckle-lowering retractor, the at least one gear wheel including a detent, the mechanism

further including a member for engaging the detent to resist rotation of the at least one gear wheel and thereby, resist withdrawal of the first buckle-lowering belt beyond the predetermined amount, the detent rotating past the member upon actuation of the mechanism for enabling withdrawal of the first buckle-lowering belt beyond the predetermined amount.

19. The occupant restraint system of claim 18 wherein the member for engaging the detent of the at least one gear wheel includes a leaf spring, the mechanism being actuatable by a predefined force applied to the first buckle-lowering belt, the detent flexing the leaf spring and rotating past the leaf spring when the predefined force is applied to the first buckle-lowering belt.

20. The occupant restraint system of claim 18 wherein the member is rotatably mounted to the at least one buckle-lowering retractor, the detent of the at least one gear wheel, during rotation of the spool in a direction for retracting the first buckle-lowering belt, engaging the member and rotating the member to enable the detent to rotate past the member, the at

least one buckle-lowering retractor including structure for resisting rotation of the member during withdrawal of the first buckle-lowering belt.